Delta Regional Ecosystem Restoration Implementation Plan (DRERIP)
Species Life History Models
Draft Guidelines

Introduction

The CALFED Bay-Delta Program Ecosystem Restoration Program (ERP) has assembled an Adaptive Management Planning Team (AMPT) to oversee preparation of the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP). The DRERIP will identify ecosystem restoration actions to be pursued in the Delta to achieve ERP strategic goals and objectives. This document provides information and guidance from the AMPT to individuals and groups who are tasked with developing species life history conceptual models for use in preparing the DRERIP.

The intent of this framework is to ensure that each DRERIP Species Life History Conceptual Model meets ERP's needs for developing the DRERIP and contains baseline level of information – it is not intended to impose a rigid formula for model development. The framework describes the purpose for developing conceptual models, the intended use of the models, and guidelines regarding the content and structure of the models.

The Ecosystem Restoration Program Plan (ERPP) identifies 116 ecosystem elements sorted into four general categories: ecological processes (7), habitats (14), stressors (16), and species or species groups (79). A list of species and species groups for which life history conceptual models will be developed is attached ("Appendix A"). The remaining ecosystem elements (grouped as processes, habitats and stressors) were refined by the AMPT to a list of 26 proposed DRERIP ecosystem conceptual models that reflect anticipated needs for the DRERIP scientific input process. The AMPT recognizes that once model development commences the list of models needed may change as gaps or overlaps are identified and as the complexities of some issues are investigated more fully. Additional models may also be developed later in the DRERIP planning process.

Purpose of species life history models

The purpose of the species life history models is to describe the life cycle and to explicitly articulate the current state of knowledge of factors influencing the life histories for at-risk and harvestable species of interest. These models will be used to (a) evaluate proposed ERP actions and targets in the Delta (i.e., "The Vetting Process" – see below), (b) identify and develop new actions to meet the ERP goals and objectives, (c) identify indicators or performance measures to measure success toward meeting ERP goals and objectives, and (d) identify research needed to fill critical knowledge gaps.

In order to be an effective tool, a model should:

- Present a complete picture of the best scientific information available regarding the species', including the source(s) of that information (i.e. peer-reviewed publication or grey literature? Research conducted within this ecosystem or derived from research elsewhere?);

- Describe the ecosystem elements (e.g., critical processes, habitats, and stressors) that control the species' population biology, including pertinent geographic locations or life cycle stages;
- Identify the critical temporal and spatial junctures where these ecosystem elements are most important to species recovery and sustainability, and highlight, when possible, specific limiting factors;
- Characterize the level of scientific understanding for each point (areas of disagreement, information gaps, etc.)
- Provide supporting references/documentation or acknowledge items for which the "best available scientific information" are the professional judgment of the author.

Identification of assumptions and gaps in the state of knowledge are especially important features of the species life history conceptual models as these items limit the predictability of management outcomes. The Action Teams that use the Species Life History Models will ask not only "*what is known about this species*?" but also "*How certain are scientists that this species behaves in the manner described in this ecosystem*?". Life history model authors should read the Appendix B, "*The Vetting Process***",** as this will illuminate the context in which conceptual models will be used.

Application of Species Life History Models (in conjunction with Ecosystem Process Models) should enable evaluation of:

- Individual and cumulative effects of restoration and non-ERP actions;
- The dynamic nature of the species' population, including the role of uncontrolled drivers (e.g., local and global weather patterns);
- The nature of long-term population trends and the extent and source of variability in those trends;
- The need for further research efforts that will clarify the probable impact of management efforts.

Conceptual model content

Each species life history conceptual model should include:

1. A graphical component;
2. A narrative component;
3. Literature cited.

The contents of each of these sections are described below.

Graphical Component. The graphical component of the life history model should, at a minimum, identify the following:

- Life cycle stages (e.g., for fish: egg, embryo, larvae)
- Temporal patterns (seasonal, annual, or other pattern in abundance or distribution)
- Geographic patterns (location and extent of key habitats)
- Important habitat attributes
- Critical processes that control species' population dynamics
- Significant stressors
- Uncertainties

Narrative Component. The narrative component of the life history model should, at a minimum, document the following:

A. *Biology, Ecology, and Status*

Biology

- Fecundity
- Reproduction
- Development (e.g., for fish: swimming ability and growth)

Ecology

- Environmental tolerances and, if known, how these change by life stage
- Environmental releasers for reproduction
- Trophic habit, position, and relationships throughout the life cycle
- Spatial distribution and timing of occurrence with particular reference to Delta occupancy
- Key potential limiting factors in completing life cycle
- Other ecological functions (e.g. does this species behavior facilitate nutrient/energy flow to different parts of the ecosystem?)

Status

- Historical and current population status

B. *Habitats, Processes, Stressors, and Linkages*

How do changes in habitats, processes, and stressors affect biology, ecology, and status? At what temporal and spatial scales does the organism respond to habitat characteristics, processes, and stressors?

Habitats

- Habitat attributes during various life stages
- Interactions of spatial and temporal patterns in habitat quality and associated physical conditions
- Historic habitat changes that may have affected the species

Processes

- Critical processes affecting the species
- Species function in the community food web (predator/prey relationships, vector for energy and nutrient transport)

Stressors

- Significant stressors affecting the species and its population status
- Limiting factors

Linkages

- Process and stressor linkages to life stage, season, and habitat

Degree of Understanding

What limits our certainty of any of the above items?

- Suggested targeted research
- Suggested monitoring activities or modifications to current monitoring efforts
- Important information gaps
- Areas of scientific disagreement

3. Literature Cited

Provide citations for all information sources (including grey literature and personal communications) used to develop the above two components.

Appendix A: **List of Species for which Life History Models will be developed**

Species List

"R" Species (Recovery)

TYPE	COMMON NAME	SCIENTIFIC NAME
Fish	Central Valley fall-/late-fall-run chinook salmon ESU	*Oncorhynchus tshawytscha (fr)*
	Central Valley spring-run chinook salmon ESU	*Oncorhynchus tshawytscha (spring)*
	Sacramento River winter-run chinook salmon ESU	*Oncorhynchus tshawytscha (wr)*
	Central Valley steelhead ESU	*Oncorhynchus mykiss (cv)*
	Delta smelt	*Hypomesus transpacificus*
	Green sturgeon	*Acipenser medirostris*
	Longfin smelt	*Spirinchus thaleichthys*
	Sacramento splittail	*Pogonichthys macrolepidotus*
Invertebrates	Lange's metalmark butterfly	*Apodemia mormo langei*
	Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*
Plants: Inland Dune Special-Status Plant Species	Antioch Dunes evening primrose	*Oenothera deltoides* ssp. *howellii*
	Contra Costa wallflower	*Erysimum capitatum* ssp. *angustatum*
Plants: Tidal Brackish and Freshwater Marsh Special-Status Plant Species	Mason's lilaeopsis	*Lilaeopsis masonii*
	Soft bird's-beak	*Cordylanthus mollis* ssp. *mollis*
	Suisun marsh aster	*Aster lentus*

"r" Species (contribute to recovery)

TYPE	COMMON NAME	SCIENTIFIC NAME
Birds	Bank swallow	*Riparia riparia*
	California black rail	*Laterallus jamaicensis coturniculus*
	California yellow warbler	*Dendroica petechia brewsteri*
	Greater sandhill crane	*Grus canadensis tabida*
	Least Bell's vireo	*Vireo bellii pusillus*

	Little willow flycatcher	*Empidonax traillii brewsteri*
	Swainson's Hawk	*Buteo swainsoni*
	Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*
Fish	Sacramento perch	*Archoplites interruptus*
Inverts	Delta green ground beetle	*Elaphrus viridis*
Mammals	Riparian brush rabbit	*Sylvilagus bachmani riparius*
	San Joaquin Valley woodrat	*Neotoma fuscipes riparia*
Plants: Vernal Pool Special-Status Plant Species	Alkali milkvetch	*Astragalus tener* var. *tener*
	Crampton's tuctoria (Solano grass)	*Tuctoria mucronata*
Plants: Tidal Brackish and Freshwater Marsh Special-Status Plant Species	Delta coyote thistle (Delta button-celery)	*Eryngium racemosum*
	Delta mudwort	*Limosella subulata*
	Bristly sedge	*Carex comosa*
	Delta tule pea	*Lathyrus jepsonii* var. *jepsonii*
Plants	Northern California black walnut	*Juglans californica* var. *hindsii*
Reptiles	Giant garter snake	*Thamnophis gigas*

"H" Species (harvestable)

TYPE	COMMON NAME	SCIENTIFIC NAME
Fish	American shad	*Alosa sapidissima*
	Striped bass	*Morone saxatilis*
	White sturgeon	*Acipenser transmontanus*
Invertebrates	Grass shrimp	*Crangon franciscorum*
	Signal crayfish	*Pacifastacus leniusculus*
Nonnative warmwater game fishes	Largemouth bass	*Micropterus salmoides*
	White catfish	*Ameiurus catus*
Upland Game	Pheasant	*Phasianus colchicus*
	Quail	*Callipepla californica*

Waterfowl	Canvasback	*Aythya valisineria*
	Mallard	*Anas platyrhynchos*
	Northern Pintail	*Anus acuta*
	White Fronted Goose	*Anser albifrons*
	Wood duck	*Aix sponsa*

"m" Species (maintain)

TYPE	COMMON NAME	SCIENTIFIC NAME
Amphibians	California red-legged frog	*Rana aurora draytonii*
	California tiger salamander	*Ambystoma californiense*
	Western Spadefoot toad	*Scaphiopus hammondii*
Fish	Hardhead	*Mylopharodon conocephalus*
Birds	Western least bittern	*Ixobrychus axilis*
	Tricolored blackbird	*Agelaius tricolor*
	Western Burrowing owl	*Athene cunicularia hypugea*
Plants: Perennial Grassland Special-Status Plant Species	Recurved larkspur	*Delphinium recurvatum*
Plants	Eel-grass pondweed	*Potamogeton zosteriformis*
Plants: Vernal Pool Special-Status Plant Species	Boggs Lake hedge-hyssop	*Gratiola heterosepala*
	Colusa grass	*Neostapfia colusana*
	Contra Costa Goldfields	*Lastenia conjugens*
	Mad-dog (or Blue) skullcap	*Scutellaria lateriflora*
	Rose-mallow	*Hibiscus lasiocarpus*
Plants: Tidal Brackish and Freshwater Marsh Special-Status Plant Species	Greene's legenere	*Legenere limosa*
	Heartscale	*Atriplex cordulata*
Reptiles	Western pond turtle	*Clemmys marmorata*

Non-native Invasive Species (Stressor)

TYPE	COMMON NAME	SCIENTIFIC NAME

Invasive Aquatic Plants	Brazilian elodea	*Egeria densa*
	Water hyacinth	*Eichhornia crassipe*
	Eurasian watermilfoil	*Myriophyllum spicatum*
	Floating pennywort	*Hydrocotyle ranunculoides*
Invasive Riparian & Marsh Plants	Giant Reed	*Arundo donax*
	Perennial Pepperweed	*Lepidium latifolium*
	Tree-of-Heaven	*Ailanthus altissima*
	Yellow starthistle	*Centaurea solstitialis*
	Edible fig	*Ficus carica*
	Eucalyptus	*Eucalyptus spp.*
	Purple loosestrife	*Lythrum salicaria*
	Salt cedar	*Tamarix spp.*
Invasive Aquatic Organisms	Asiatic freshwater clam	*Corbicula fluminea*
	Chinese mitten crab	*Eriocheir sinensis*
	Zebra Mussel	*Dreissena polymorpha*
	Inland silverside	*Menidia berylina*
	Wakasagi	*Hypomesus nipponensis*
	Northern pike	*Esox lucius*
	Mysid shrimp	*Acanthomysis bowmani*
	New Zealand mud snail	*Potamopyrgus antipodarum*
Nonnative Wildlife	Bullfrog	*Rana catesbeiana*
	Brown headed Cowbird	*Molothrus ater*
	Red Fox	*Vulpes vulpes regalis*
	Red-eared Slider	*Trachemys scripta elegans*
	European starling	*Sturnus vulgaris*
	Norway rat	*Rattus norvegicus*
	Black rat	*Ratus ratus*

Appendix B: The Evaluation Process

The DRERIP Species Conceptual Models will be used to help make informed decisions about the types of actions proposed to be pursued in the Delta, and whether those actions should be pursued as targeted research, pilot projects, or full-scale projects. Potential ecosystem restoration actions for the Delta are identified in multiple ERP planning documents, including Ecosystem Restoration Program Plan (ERPP) Volumes I and II, ERP Strategic Plan, Phase 2 Report, Water Quality Program Plan, Draft Stage 1 Implementation Plan, Record of Decision ("ROD"), as well as other sources. The DRERIP science input process envisions a scientific vetting of all previously identified Delta actions, including programmatic actions (defined activities intended to achieve ecosystem restoration targets) and targets (qualitative or quantitative statement of a strategic objective).

The purpose of vetting is to evaluate, clarify, and categorize actions in light of current scientific knowledge and understanding. Vetting will involve a close examination of proposed actions and targets so that they are pursued with better scientific rationale for each action in order to ensure each is well understood and documented. Essentially, the conceptual models represent the information base for evaluating if an action will have its intended effect, and what the potential unintended effects might be (i.e. is it worthy, and what are the risks?).

Vetting starts with a listing of previously identified Delta ERP actions which are sorted and evaluated through a three-step process as described below and shown graphically in Figure 1.

Step 1: Preliminary Sorting - separates out actions that have been completed in whole or in part and identifies remaining actions as either research or implementation actions;

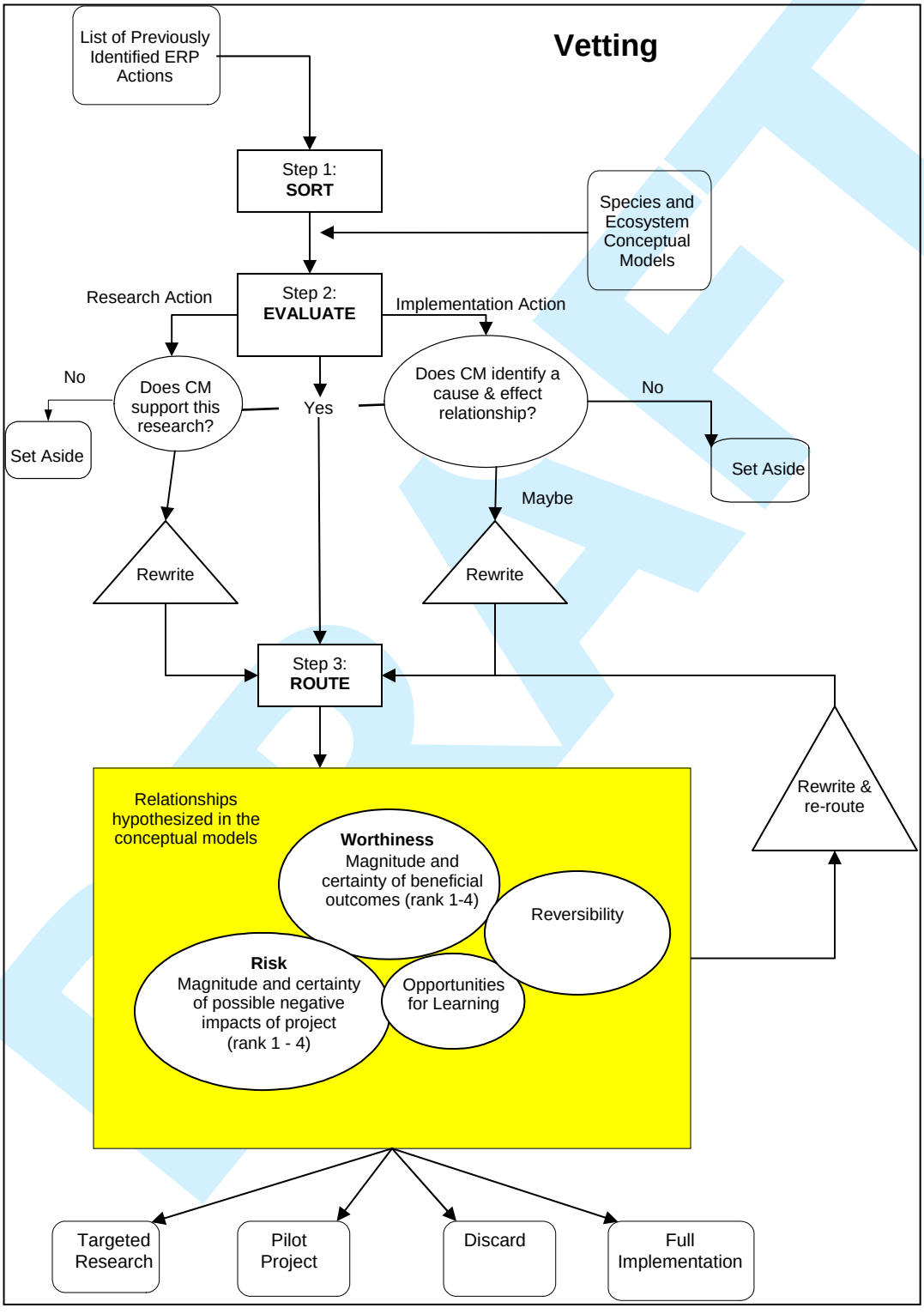
Step 2: Initial Evaluation - looks at the overall clarity of the action (as written), including whether a clear cause and effect relationship is identified (either explicit or implicit) and whether the action is clearly written (ERP actions in need of clarification will be rewritten using a prescribed rewriting process); and

Step 3: Adaptive Management (AM) Routing - provides a procedure for categorizing the actions into specific implementation categories.

Step 1 of the vetting process will be conducted by agency staff. Steps 2 and 3 will be performed by an Action Team consisting of scientific experts convened specifically to develop conceptual models for the Delta and to vet ERP actions using those models.

The DRERIP conceptual models will be used in Steps 2 (Initial Evaluation) and 3 (Adaptive Management Routing) of the vetting process. During Initial Evaluation, conceptual models will be used to determine if there is a known or hypothesized cause and effect relationship that suggests that the action is reasonable to consider from a scientific perspective. In the Adaptive Management Routing process, the conceptual models will form the basis for identifying expected outcomes (or consequences) and the Anticipated Magnitude and Understanding of those outcomes.

Figure 1: Vetting Process



Initial Evaluation: Once actions have been sorted, each action will be evaluated with regard to the following three questions:

1. Is there a common level of understanding of the action proposed and the expected outcome, that allows for an evaluation of the action without further clarification?
2. Are there similar or related actions, or other program documents that provide information or approaches that enlighten the common level of understanding without re-writing the action?
3. If necessary (based on questions 1 and 2 above), can the action be re-written to achieve question 1, considering other similar or related actions in the Actions-Targets Database?

Guidelines for rewriting actions are included in the document "*DRERIP Vetting Process for ERP Actions*".

Adaptive Management Routing: The process of adaptive management routing involves categorizing ERP actions that survive the Preliminary Sorting and Initial Evaluation steps into one of five implementation categories:

1. **Targeted Research** – Pursue targeted research.
2. **Pilot -** Pursue a pilot or demonstration project to test the action.
3. **Full-Scale** - Pursue full-scale implementation of the action.
1. **Rewrite and Re-route Action** – Re-write action to reflect an alternative approach.
2. **Discard** – Remove from consideration based on analysis of outcomes.

The first step in routing is to identify and describe the outcome(s) that might be expected to result from a given ERP action. This includes both potential positive and negative outcomes. Outcomes are then evaluated with regard to routing criteria. Positive and negative outcomes are scored with regard to the magnitude and understanding of the outcome. These scores are then combined to estimate the worth of, and the risk associated with, the proposed action. After the worth and risk of a given action are evaluated, the reversibility of the action and the opportunity for learning associated with the action are scored. Ranking criteria and methodologies for vetting each potential ERP action are contained in the document "D*RERIP Vetting Process for ERP Actions*"

The Action Team will rely on the conceptual models (species and ecosystem) as well as other sources of information in identifying outcomes (positive and negative) and in scoring the expected magnitude of these outcomes as well as the degree of understanding ("certainty") that underlies the expected outcome. The team may explore clarifications or modifications to the conceptual models during this process.

Vetting ERP actions is intended to focus on questions of science and involve an objective and transparent process. Once actions have been vetted from a scientific, adaptive management perspective, a process for prioritizing the actions can occur. Vetting will inform prioritization and project selection but will not, in and of itself, constitute prioritization.